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OPERATIONALIZATION OF INFORMATION TECHNOLOGY FOR THE 21ST CENTURY (IT-21): THE FLIGHT SCHEDULING FUNCTION IN PATROL SQUADRON 40 AS A CASE STUDY

by

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In the past several years, greater exploitation of information technology to increase leverage of information has become a central focus in the military. This focus is reflected in a number of strategic vision documents. Two significant examples are "Joint Vision 2010" signed in 1996 by the Chairman of the Joint Chiefs of Staff and the 1997 Quadrennial Defense Review Report. Achieving and using information superiority is seen as essential to future military success. This has led to the emergence of a new warfare paradigm: network-centric warfare.

Towards this end, the Navy's service-wide IT improvement initiative is Information Technology for the 21st Century (IT-21). IT-21 establishes a standard for IT capability to be achieved throughout the Navy within which Navy units can shape their IT improvements.

This study explores a requirements-approach for planning improvement of IT through IT-21. Specifically, it focuses on a single function of one squadron: flight scheduling in Patrol Squadron 40. This study addresses how to establish information requirements, assess current IT performance, and formulate specifications by which to drive planning for IT improvement. It concludes by mapping IT-21 components to requirements to provide VP-40 with a plan for improving its flight scheduling process through IT-21.

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ABSTRACT

In the past several years, greater exploitation of information technology to increase leverage of information has become a central focus in the military. This focus is reflected in a number of strategic vision documents. Two significant examples are "Joint Vision 2010" signed in 1996 by the Chairman of the Joint Chiefs of Staff and the 1997 Quadrennial Defense Review Report. Achieving and using information superiority is seen as essential to future military success. This has led to the emergence of a new warfare paradigm: network-centric warfare.

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I. INTRODUCTION

A. BACKGROUND

The end of the Cold War and the Soviet empire's disintegration were the genesis for tremendous change in the United States' military. The ensuing reductions in the United States' Armed Forces – the defense budget by 38 percent, force structure by 33 percent, and procurement programs by 63 percent from 1985 to 1997 – were dramatic. (Cohen, 1997) Meanwhile, regional conflicts grounded in longstanding ethnic, religious, and political hatreds emerged as the primary threat facing the U.S. military. These combined events necessitated the U.S. finding new and more efficient approaches to warfare.

In response, the military's leadership sought to develop a new strategic vision by which to guide the military. In 1996, the Chairman of the Joint Chiefs of Staff (CJCS) published "Joint Vision 2010" (JV2010), the strategic vision for the military into the 21st century and the conceptual template for channeling the efforts of the Armed Forces.

In 1997 the Quadrennial Defense Review (QDR) examined the new world order and threats vis-à-vis existing defense structure. Formal recommendations were made for changes in the Armed Forces to ensure the new threats and unforeseen threats in the future would be decisively met. In the words of the National Defense Panel, "if we are to be successful in meeting the challenges of

the future, the entire U.S. national security apparatus must adapt and become more integrated, coherent, and proactive." (Cohen, 1997)

A resounding theme common to both JV2010 and the QDR Report was the need for the military to leverage information and achieve information superiority to ensure future success. In conjunction with the QDR, one of the National Defense Panel's recommendations was to "exploit information technology to integrate forces and platforms more effectively." Defense Secretary William Cohen elaborated further in saying, "we must exploit these and other technologies to dominate in battle." (Cohen, 1997)

Information superiority's fundamental and universal role, along with leveraging technological opportunity, in ensuring the U.S. military's effectiveness in joint warfighting and its dominance over enemies in the future is illustrated within the context of JV2010's concepts in Figure 1.1. Information superiority is an equally crucial component of each of the Services' warfighting vision documents.

Network warfare, robust information technology (IT) infrastructure and information exchange with dispersed forces are key to achieving information superiority. It is from this perspective that the Navy's information technology (IT) strategy initiative, Information Technology for the 21st Century (IT-21) was conceived. (Clemins, 1997) "IT-21 is a fleet driven reprioritization of C4I programs of record to accelerate the transition to a PC based tactical/tactical

support warfighting network." (CINCPACFLT, 1997) IT-21 is a joint initiative of the Commander in Chief, U.S. Atlantic Fleet (CINCLANTFLT) and Commander in Chief, U.S. Pacific Fleet (CINCPACFLT).

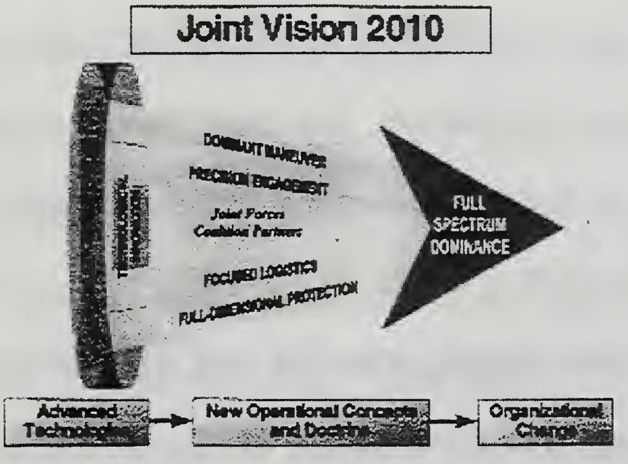

Figure 1.1. Joint Vision 2010 Concept (DOD, 1997)

IT-21's goal is linking U.S. and allied forces together in a network that is capable of voice, video, and data communication from individual desktop personal computers (PCs), thereby enabling warfighters to exchange classified or unclassified, and tactical or non-tactical information by December 1999. (Clemins, 1997)

B. OBJECTIVES

The objective of this thesis is to demonstrate how a requirements plan can be combined with IT-21 in a complementary fashion to improve the IT supporting an organizational function. The thesis first examines the IT-21 initiative in the context of its intended role in individual units of the operating fleet. Patrol

Squadron 40 (VP-40), based at Naval Air Station, Whidbey Island, Washington will be used as a case study. The thesis uses the results of an on-site survey of VP-40 that examined its IT, IT requirements and gaps between the two, which identified a specific important function where IT is deficient: flight scheduling. Subsequently, the thesis provides an overview of flight scheduling and IT's role and shortcomings that function. The thesis goes on to develop IT requirements specifications for flight scheduling and demonstrates how the requirements could be mapped onto IT-21.

A secondary objective is that this work serves as a model for similar efforts in other functional areas in conjunction with IT-21.

C. THE RESEARCH QUESTION

Simply stated, the basic research question is how can IT-21 be operationalized? IT-21's purpose is to facilitate achieving information superiority. IT-21 provides hardware standards and a COTS software product set by which to establish a network infrastructure that is key in achieving information superiority. Is a ubiquitous IT-21 network making information accessible more widely and quickly enough to ensure information superiority? Improving the quality of information and the IT-based processes by which it is produced is important, too. IT-21 does not provide a roadmap as to how its infrastructure may be used to improve IT support of specific functions. How can IT-21 be part of IT improvement in a single unit, in a specific function? For example, how might VP-

40 improve the IT supporting the Operations Department's flight scheduling in conjunction with IT-21?

D. SCOPE, LIMITATIONS, AND ASSUMPTIONS

1. Scope

The subject, IT-21 implementation in fleet units, was purposely limited because of the myriad issues associated with IT-21, the quantity and diversity of units and the many nuances unique to each. Originally, the study focused on one unit, VP-40, and how it could incorporate IT-21 implementation into a requirements-based IT improvement plan. Subsequently, an IT survey of the entire squadron identified numerous functional areas desperately needing IT improvement. Developing a complete squadron solution was deemed infeasible given time and resource constraints. Instead, one particularly vexing and important function for which a solution plan would have high potential payoff was selected: flight scheduling. Furthermore, it was hoped that developing a requirements-based IT improvement plan for one function would produce a model for similar efforts in other squadron functions.

The scope of this thesis includes a brief examination of IT-21, an examination of VP-40's flight scheduling process and supporting IT, specifying the information requirements of flight scheduling, and finally, mapping those requirements onto IT-21.

2. Limitations

The foremost extraneous factor limiting the research effort was IT-21's nascent nature. Regarding IT-21 implementation for units other than battle group ships and the supporting shore establishment, little information existed beyond the initial documents announcing IT-21. And even for forces afloat and the shore establishment, formal strategies, guidance, policy, and procedures are still taking form.

Also, sponsorship by VP-40 given its limited funding, geographic locations, and limited availability due to training preparations for an upcoming six-month deployment to the Western Pacific precluded were limiting.

3. Assumptions

The reader is assumed to be familiar with the Navy in general, and with the organization and mission of a maritime patrol squadron in particular. Further it is assumed that the reader is familiar in general terms with historical problems in IT employment in the Navy, and with IT-21. Lastly, it is assumed the reader is familiar with systems analysis and design as it applies in general to IT.

Several assumptions underlie the research topic. The one impacting this thesis more than any other is that the standards jointly established by CINCLANTFLT and CINCPACFLT for IT-21 are fixed for the period of time in which this thesis work was performed.

Another notable assumption is that VP-40 represents an average fleet squadron in terms of its present state of IT and its IT requirements. Further, it was assumed that VP-40's funding would not be increased to cover anything except the hardware needed to comply with IT-21 standards. For example, VP-40 could not afford to obtain external expertise from contractors or Department of Defense (DOD) Working Capital Fund (WCF) activities like Defense Information Systems Agency (DISA) or Naval Computer and Telecommunications Stations (NCTSs). Also, other key resources (e.g., trained personnel) were presumed to remain limited at present levels throughout the implementation of IT-21.

E. ORGANIZATION OF STUDY

The remainder of the thesis is organized as follows: Chapter II discusses the context of VP-40's effort to improve its IT, and includes an overview of IT-21 and VP-40's initiative. Chapter III describes the flight scheduling function, its supporting IT and IT shortcomings. Chapter IV examines the information requirements specifications of flight scheduling. Chapter V demonstrates how the IT requirements plan for flight scheduling can be mapped onto IT-21 such that IT-21 is an integral component of the plan.

II. IT IMPROVEMENT

A. INTRODUCTION

Spurred on by the Navy's IT-21 initiative and an executive officer educated in IT management at the Naval Postgraduate School, VP-40 early in 1998 initiated action to improve its IT. The goal was to better equip the squadron with the type of PC-based IT commonly found in many organizations to enable VP-40 to become more efficient, better coordinated, and more agile.

This chapter provides an overview of IT-21, discusses the importance of planning IT improvement, and finally discussesVP-40's IT.

B. IT-21

1. Origin

IT-21 is a product of fundamental changes in the U.S. military and in technology. The end of the Cold War and the disintegration of the Soviet Union led to the reductions in U.S. military forces and funding. The smaller military became much more reliant on once-rare joint (i.e., multi-Service) operations. Meanwhile, numerous regional threats arose that were often difficult to predict. With U.S. interests the world over, the military was expected to respond quickly and effectively.

> *...we are operating in a paradoxical time of increased need for our forces, coupled with decreased resources to support them. Defense budgets have shrunk, but the demand for our forces around the world has grown. (Clemins, 1997)*

Concurrently, personal computers, local area networks (LANs) and the Internet emerged as powerful means for leveraging information. Commercial off-the-shelf (COTS) PC-based IT rapidly equaled or surpassed proprietary military-unique systems' capability and affordability.

Soon the Navy realized the substantial opportunity afforded in COTS IT to increase efficiency and effectiveness in force employment to compensate for the loss in sheer force size. COTS IT is now driving an ongoing fundamental change in naval warfare. The Navy is shifting its warfare paradigm from "platform-centric" (i.e., ship-centered), in use for over 200 years, to "network-centric."

Platform-centric warfare's characteristics are huge capital investment in warships, large overhead in organizational structure and combat power generated by massing forces. Under that paradigm, victory is achieved by massing overwhelming forces against a foe to inflict unbearably high casualties upon him.

Network-centric warfare is quite different. It uses information technology to focus and leverage information and intellectual capital to increase combat power. Network-centric warfare requires less infrastructure and overhead. It closes the distance between decision-makers and combatant forces, flattening the command hierarchy and thereby fostering greater speed of command. Lulls in operational tempo, characteristic of platform-centric warfare, due to hierarchical decision-making are greatly reduced. The graphic analog is transforming a step-

function into a continuous function. Reducing operational lulls means the enemy has less opportunity to seize or regain initiative. (Dalton and Johnson, 1997)

The Navy's leadership and U.S. military leadership overall sees network-centric warfare and information superiority as crucial to future success. This fact is reflected in the military's overall strategic vision document for the military into the year 2010, known as JV2010, as well as each of the Services' individual vision documents.

2. IT-21 Overview

Information Technology for the 21st Century, or IT-21, the joint initiative by the Atlantic and Pacific Fleets, is intended to make network-centric and information superiority a reality. (Clemins, 1997) The efficacy of network-centric warfare depends on information superiority. IT-21 was formally launched on 30 March 1997.

IT-21 is not an acquisition program, but rather a strategy. It is a strategy for reprioritizing existing command, control, communications, computers and intelligence (C4I) programs to accelerate the Atlantic and Pacific fleets' transition to a personal computer (PC) based tactical and support network. (Clemins, 1997) IT-21's goal is linking U.S. forces (and eventually allied forces, too) in a network that enables exchanging tactical or non-tactical, and classified or unclassified information in voice, video and data formats from a single desktop PC. Figure 2.1 illustrates the infrastructure that exists today for the three information forms "stovepipes" (i.e., isolated applications lacking interoperability with other

applications), must form a client-server environment, and must be based on industry standards and COTS technology. (Clemins, 1997) This guidance for IT-21 conforms to broader DOD IT guidance in the Joint Technical Architecture (JTA) and the Defense Information Infrastructure Common Operating Environment (DII COE).

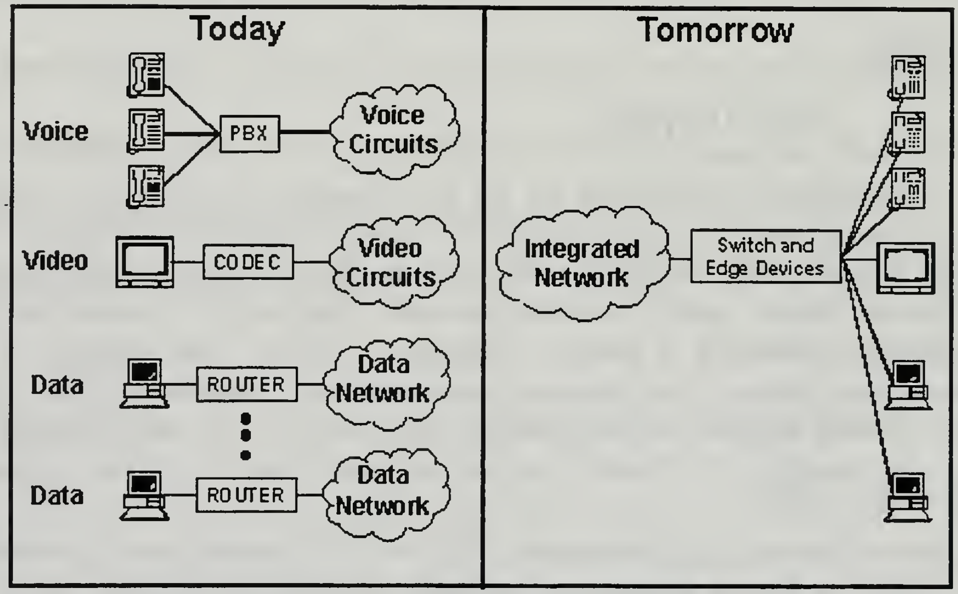

Figure 2.1. Transition of Information Technology (ITSG, 1998)

IT-21 must be implemented rapidly. The reason is that in December 1999 the Department of Defense's (DOD's) messaging system, the Automatic Digital Network (AUTODIN), will be deactivated. (Clemins, 1997) AUTODIN has no follow-on system. Linked networks, electronic mail (e-mail) messaging and user access through PCs – all of which will be established using COTS IT – will have to replace AUTODIN.

3. Standards

The naval message from CINCPACFLT announcing IT-21 established a set of minimum standards for hardware and a software product set. The details of that message are contained in Appendix.

4. Information Superiority is More than Just Good IT

IT-21's foundation has two elements: (1) a minimum standard IT capability for every ship and unit, and (2) a universal network linking those ships and units across the Atlantic and Pacific fleets. Together the two elements are intended to enable network-centric warfare and information superiority. However, IT-21's foundation alone does not necessarily produce information superiority.

Information superiority (ignoring its offensive component of direct action against enemy information and information infrastructure such as disruption, deception and denial) encompasses more than good accessibility to information and the ability to achieve large-volume throughput by virtue of robust IT. Information superiority includes information quality as well.

Joint Publication 6-0, Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations characterizes information quality using seven criteria: accuracy, relevancy, timeliness, usability, completeness, brevity, and security. Table 2.1 defines the criteria. In other words, information quality includes the content as well as the efficacy with which information is produced and handled.

Table 2.1. Information Quality Criteria (Joint Pub 6-0, 1995)

INFORMATION QUALITY CRITERIA	
ACCURACY	Information that conveys the true situation.
RELEVANCE	Information that applies to the mission, task, or situation at hand.
TIMELINESS	Information that is available in time to make decisions.
USABILITY	Information that is in common, easily understood format and displays.
COMPLETENESS	All necessary information required by the decision-maker.
BREVITY	Information that has only the level of detail required.
SECURITY	Information that has been afforded adequate protection where required.

The Navy's Information Technology Standards Guidance (ITSG) provides a slightly different set of characteristics of information quality, as listed in Table 2.2. Good production and handling of in formation entails more than just using superbly capable IT, it means using IT superbly. So, information superiority demands the well-planned application of IT as well as the best information content.

Table 2.2. Information Quality Measures (ITSG, 1998)

INFORMATION QUALITY MEASURES	
ACCURACY	The probability that the value is correct.
PRECISION	The fidelity, granularity or relevance of the information.
CURRENCY	The elapsed time from the creation, discovery or validation of the information to the present time.
COMPLETENESS	The number of information elements in the information base as a function of the total number of information elements in the entire set.
DUPLICATION	The percentage of duplicate data elements in the information set.
ACCESSIBILITY	The degree in which the information stored or computed within the infrastructure is available to the target subscriber.

C. THE IMPORTANCE OF PLANNING IT IMPROVEMENT

Accurately assessing the quality of existing information systems (ISs) is important because that forms the baseline from which to plan IT improvement. Accurate assessment requires a systematic approach. That approach begins with identifying and defining organizational functions, then analyzing their information management needs. Information management requirements must be precisely defined. Then, the existing IT's efficacy and efficiency in meeting the information management requirements must be evaluated. Capability deficiencies that are discovered are transformed into IT requirement statements. Finally, IT requirements are melded into a plan for application of IT to fulfill the information management needs.

The IT plan must be accurate and coherent to ensure appropriate, integrated, and economical application of IT. In implementing IT-21, correct plans are especially important. In the words of Admiral Clemins, CINCPACFLT, in July 1997, "the year 2000 is rapidly approaching. There will be sufficient money to implement IT-21, but there will not be enough money to do it twice. It must be done right the first time."

D. VP-40'S NEED FOR IT

Early in 1998, the executive officer of VP-40 began an earnest effort to increase the squadron's efficiency and effectiveness by improving the quality and use of its IT. IT-21 figured significantly into this initiative.

1. The Assessment Process

VP-40 began a systematic assessment of its IT in early 1998. While normally such an assessment would begin with identifying and defining organization functions, this was unnecessary for VP-40. Navy ships and units have standard organizational structures and functions (by type of ship or unit) that are already clearly identified and well defined in manning documents and standard operating procedures. Therefore, VP-40's attention immediately turned to assessing how well VP-40's IT supported its functions.

In May of 1998 as part of work preliminary to this thesis, an on-site survey of VP-40's IT was conducted. The squadron's existing IT was assessed based on three days of visiting all functional areas of the squadron and interviewing key personnel in each. The results of the survey were intended to help the squadron appropriately shape its implementation of IT-21.

2. Assessment Results

PCs in use ranged between 286 microprocessors to low-end 486 processors. Of 49 PCs in use, only 14 were connected to a squadron LAN. The LAN had been only recently established. It was established based on Ethernet technology and a Novell network operating system (NOS). LAN connectivity was primarily limited to VP-40's department heads plus the commanding officer and the executive officer.

The squadron's primary use of PC software was for word processing, databases and spreadsheets at department- and division-levels. Software generally was not standardized across the squadron. Exceptions were e-mail and the naval message distribution software.

Databases were maintained on stand-alone PCs. Whole databases or elements of them were often duplicated on multiple stand-alone PCs. Data validity for any one instance of a database or data element was questionable. Synchronization occurred only through labor-intensive manual reviews and updates. Of similar difficulty was fusing information from various databases to gain synergistic benefits.

Internet access was non-existent. This was a function of lack of hardware infrastructure. Inability to access the Internet retarded the squadron in functional areas such as Naval Air Training and Operating Standards (NATOPS), where access to other commands' NATOPS Internet web sites containing flight safety information and training materials is very important. Overall, VP-40's use of IT was very rudimentary and not well orchestrated. VP-40 was clearly below the IT-21 standards in every respect.[1] The squadron lacked an IT infrastructure, and lacked a strategy for establishing and employing one.

[1]Not included in this characterization was the Maintenance Department's Naval Aviation Logistics Command Information Systems suite. NALCOMIS is a Navy legacy system, sponsored by the Naval Air Systems Command, solely for management of aircraft maintenance activities in the squadron and interface with the higher level intermediate maintenance function resident in the NAS, and the supporting NAS supply department. The intra-squadron maintenance functionality is supported by an Ethernet LAN using a PC server and a Novell network operating system connecting PC terminals throughout the squadron's Maintenance Department.

E. CHAPTER SUMMARY

Information superiority is crucial to U.S. forces' ability to generate combat power in the future. The Navy's recognition of this is reflected in its shift from platform-centric to network-centric warfare. Network-centric warfare requires a new type of infrastructure; one focused on IT rather than ships and aircraft. The joint CINCLANTFLT-CINCPACFLT initiative known as IT-21 is the plan for establishing the new IT infrastructure.

In addition to highly capable IT infrastructure, information superiority demands high quality information. Information quality is a product of the degree of quality in producing and handling the information as much as it is a product of the quality of content. That is, in turn, a function of the quality of the design and application of the IT that supports the process producing the information. Quality in IT design grows from systematic assessment of functional processes and their information management requirements.

VP-40 is an example of a Navy unit striving to shape its IT-21 implementation its needs. The squadron began its effort by systematically assessing how well its current IT meets its information requirements. From this general baseline, functional areas will be targeted, with those having the highest potential payoff done first. The Operations Department's flight scheduling function is a critical function for which carefully designed application of IT-21 infrastructure may yield significant benefit.

III. ILLUSTRATIVE IT IMPROVEMENT: VP-40 FLIGHT SCHEDULING

A. INTRODUCTION

The activity of a squadron revolves around operating its aircraft and training its aircrews. Training aircrewmen, and operating and maintaining aircraft is a complex endeavor that must be carefully choreographed.

The squadron's operations officer guides the squadron's activity. The flight schedule is the means by which the operations officer communicates what flight activity or missions will take place on a daily basis. Flight scheduling, therefore, is a critical function.

Flight scheduling by its nature is information-intensive. Yet currently, the function is performed without any significant use of IT. Therefore, the flight scheduling function is a rich and promising target in VP-40's overall effort to improve its IT.

B. FLIGHT SCHEDULING PROCESS

1. Background

Proficiency or readiness is a rating of a squadron's ability to perform its assigned missions. A squadron's assigned missions can cover a number of the Navy's 13 standard Primary Mission Areas (PMAs). A squadron achieves readiness through training in its applicable PMAs. Squadron readiness is an aggregate average of individual aircrewmen's readiness. Individual aircrewmen

readiness or currency is based on training accomplished in applicable PMAs. (VonBrabant, 1993)

Achieving and maintaining proficiency requires squadrons to constantly train - primarily by flying their aircraft, but with use of flight simulators as well. Normally training is conducted in a 24-month cycle. During the cycle, readiness level requirements for applicable PMAs vary according to the PMA and point in time in the squadron's cycle. At 18 months, the goal is for the squadron to be at maximum readiness. Usually at this point the squadron begins a six-month operational deployment. Maximum readiness is the goal because during the deployment, higher level commanders might call upon the squadron to perform any or all of its missions. (VonBrabant, 1993)

2. What Shapes a Squadron's Schedule

Specific training requirements are a function of the type and model of aircraft the squadron flies. Each type and model of aircraft in the Navy has a prescribed set of training syllabi. The Navy's two most senior commanders who are responsible for training and equipping operational naval air forces - the Commander, Naval Air Force, U.S. Atlantic Fleet and Commander, Naval Air Force, U.S. Pacific Fleet - jointly define the syllabi. (VonBrabant, 1993)

The set of syllabi for a model of aircraft specifies various training events (or flights) in the PMAs applicable to that aircraft model. Events must be successfully completed and periodically repeated within a given time frame. As aircrewmen successfully progress through the syllabi, readiness levels increase

incrementally. But, achieving greater readiness costs the squadron use of scarce resources. Restricted resources include: time, people, funding for the cost of operating aircraft (e.g., fuel, replacement components), materially ready aircraft (i.e., fully mission capable and partially mission capable), ordnance, and other assets (e.g., ranges, facilities, other squadrons, ships, etc.). Also, a restriction is the need to maintain equity in flight time among aircrews and individual aircrewmen. (VonBrabant, 1993)

3. Prominent Roles in Squadron Flight Scheduling

a. Training Officer

The squadron training officer establishes monthly and weekly training plans. The basis of the plans is the prescribed set of syllabi pertaining to the squadron's type and model of aircraft. Training plans tailor the execution of the squadron's syllabi by accounting for the squadron's current aircrew proficiency, combat readiness and point in the training cycle relative to goals not yet attained. Training plans are specific guidance to ensure the squadron progresses satisfactorily in training and achieving readiness goals. The training officer provides training plans to the squadron operations officer.

b. The Operations Officer

The operations officer is responsible for scheduling flights to meet training plans. He must formulate schedules on two temporal horizons: daily for the current week, and several weeks to months in the future.

(1) **Long-Term Planning.** On a monthly basis as a long range scheduling aid, the operations officer usually publishes an operations forecast. Normally it covers from the next week to at least several months, and often up to 12 months or more. For ease of use, its most often in the form of a planning calendar. The blocks of days and weeks display important events, such as major training exercises and operational commitments, on the dates on which they are to occur. Also, the calendar often lists the number of aircraft required for each event, and special equipment or configurations.

(2) **Short-Term Planning: Flight Scheduling.** The current week's operations, on a day-to-day basis, are the focus of flight scheduling. Daily, the operations officer produces a detailed flight schedule. A flight schedule is the operations officer's plan for employing aircraft and aircrews to accomplish specific missions. Missions may be for training or real-world operations. The flight schedule should reflect optimal mission accomplishment within constrained resources under a number of conditions. Flight scheduling is an optimization problem. In peacetime, the ongoing daily challenge is to maximize the squadron's combat readiness given limited resources, and a complex set of variables whose values constantly change.

4. Flight Scheduling Process Overview

a. Input

Input into the flight scheduling process falls into to general categories: requirements and resources. Both are constraints and form the bounds

within which the operations officer must attempt to maximize the squadron's progress in combat readiness for that day.

(1) **Requirements.** Requirements define exactly what is to be accomplished by flying the aircraft. Requirements may be training or operational. In a peacetime environment, most requirements will concern training, however some may be operational in nature. Training requirements focus on incremental improvement or periodic refreshment of particular skills in PMAs. An implicit requirement is to advance every aircrewmen's skills (i.e., equitable use of resources in training aircrews). Operational requirements are whatever higher authority dictates (e.g., anti-drug surveillance patrol).

(2) **Resources.** Input about resources defines the limits of various assets available to the squadron with which to satisfy requirements. Resources primarily are aircraft, funding and personnel. Other resources may be special equipment and supporting facilities.

b. Transformation

Input starts a complex process. The operations officer must simultaneously consider multiple constraints, conditions and goals. Sometimes variables have subtle interrelationships, and so seemingly straightforward choices may have unanticipated ancillary affects. Some requirements have a degree of flexibility as to when they must be scheduled to occur. Further complicating the process is the limited time in which flight scheduling is performed (i.e., less than a

day for a daily schedule). Transforming input into an optimum training flight schedule is a daunting task.

The operations officer acts as an arbiter more than as a unilateral decision-maker. Often, the operations officer seeks additional information or advice from those providing the original input, as they are the subject matter experts for their areas of input. This is particularly true regarding requirements for which there is some schedule flexibility.

The operations officer must have maximum opportunity to collaborate with others and to perform sensitivity analyses (on singular choices as well as a proposed flight schedule). Shaping an optimum flight schedule is iterative, collaborative and evolutionary.

c. *Output – the Flight Schedule*

The product of the process, of course, is a daily flight schedule.

5. Complexity of Flight Scheduling for a Long-Range Maritime Patrol Squadron

For a long-range maritime patrol squadron like VP-40, the problem of flight scheduling is particularly complex. In addition to the basic variables of flight scheduling common to all squadrons – which assume a single-pilot aircraft – described earlier, a patrol squadron has the additional dimension of a large, multi-man aircrew. Each P-3 patrol aircraft requires a complement of 12 aircrewmen, including officers (pilots and naval flight officers) and enlisted sailors. The squadron has up to eight aircraft. There is at least one 12-man aircrew per aircraft.

Each individual aircrewmen has unique training requirements based on the assigned role aboard the P-3. Plus, each 12-man crew as an entity has training requirements it must achieve as one.

The multitude of variables in a patrol squadron makes the process of optimally scheduling flights demanding. This rigorous task must be performed daily to produce a schedule for the upcoming day's events, plus one additional time per week to produce a weekly schedule for the upcoming week.

C. VP-40'S FLIGHT SCHEDULING PROCESS

VP-40's flight scheduling occurs in the context and follows the basic process described in the previous section's overview. Although the process is information-rich, VP-40 does not currently employ any significant IT in flight scheduling.

1. Logical Overview

Data flow diagrams, a tool of information systems analysis and design, can help illustrate the logic of VP'40's flight scheduling process. The context diagram in Figure 3.1 illustrates the major entities and logical data flows of the process.

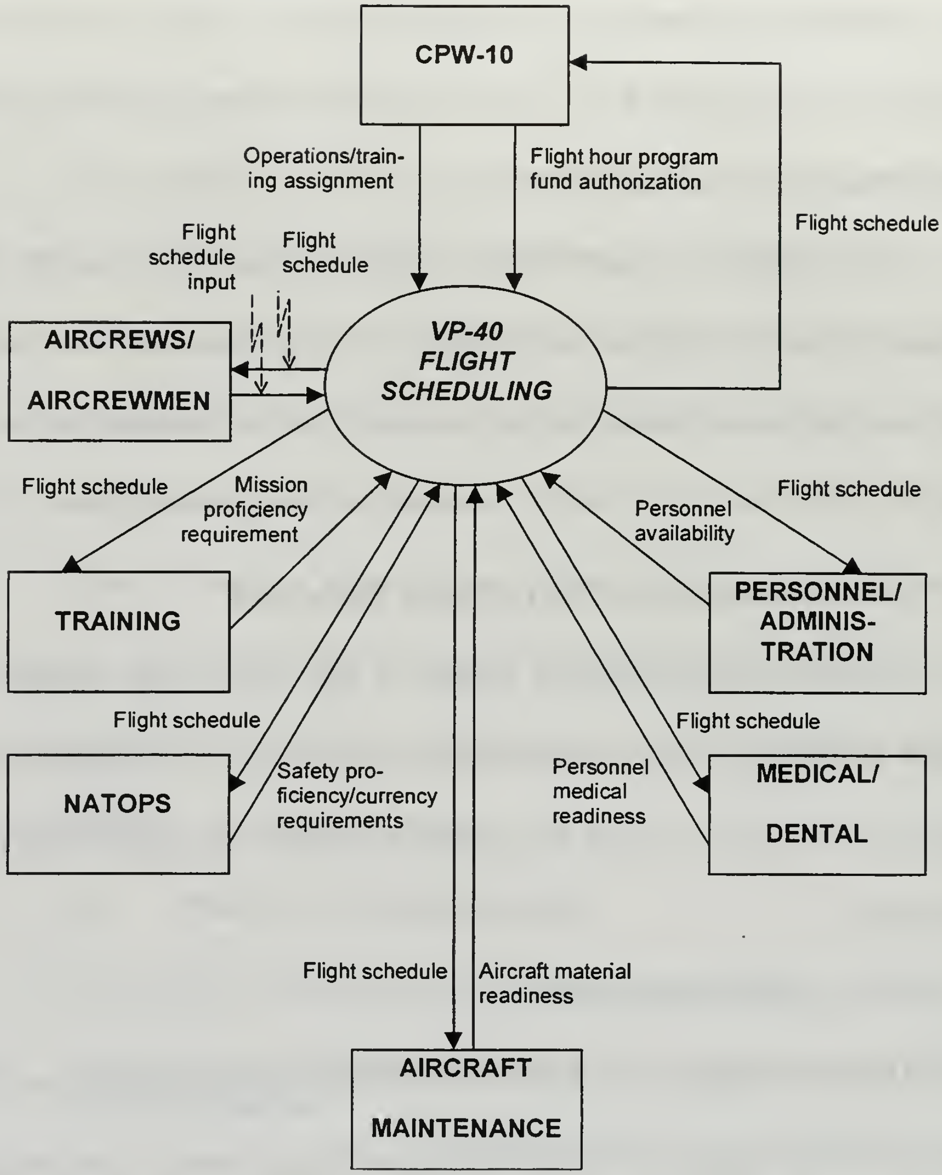

Figure 3.1. VP-40 Flight Scheduling Logical Context Diagram

Figure 3.2, a level-one decomposition diagram, models the process in greater detail, illustrating the major information transformation processes within flight scheduling.

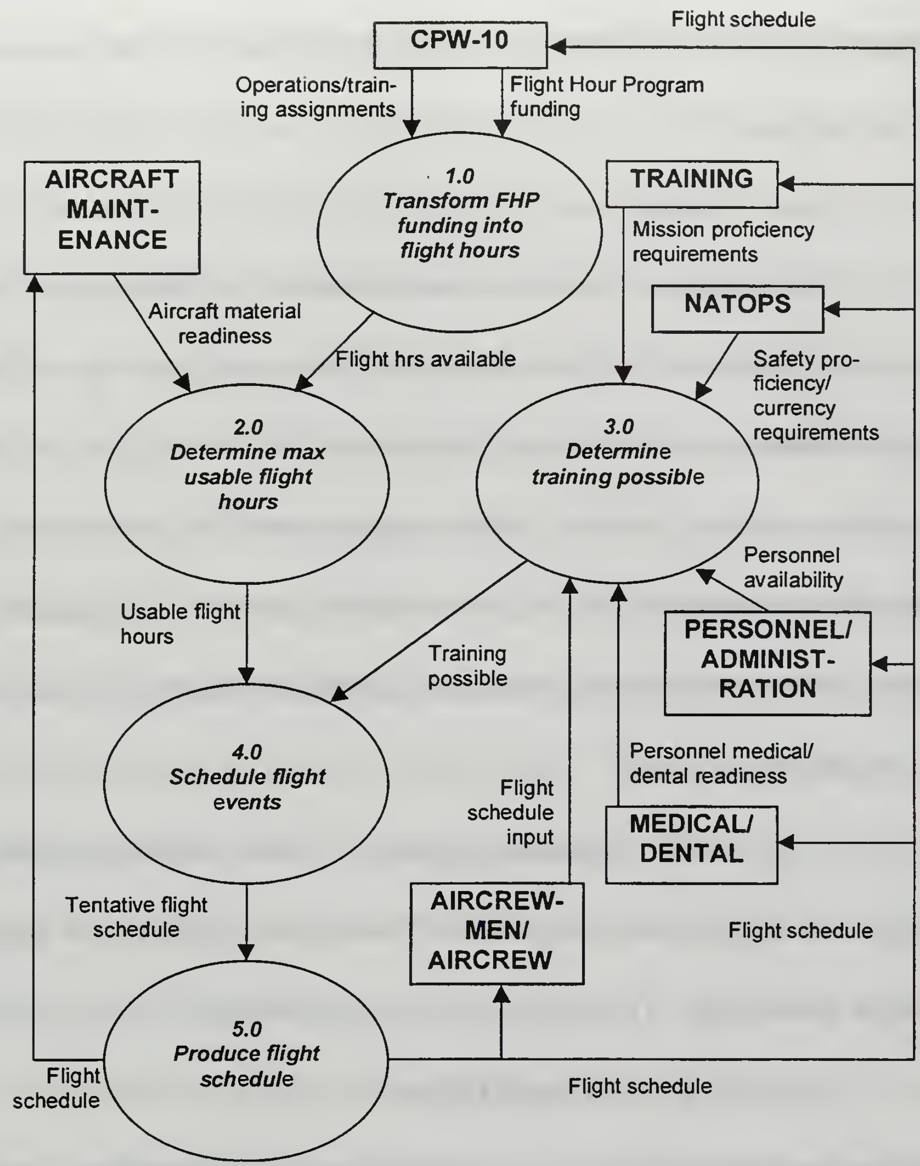

Figure 3.2. VP-40 Flight Scheduling Level-One Logical Decomposition Diagram

2. The Physical Process

Input enters the flight scheduling process in hardcopy form. However, some input is entered into PC applications for intermediate transformation. The product is electronically stored, but then used in hardcopy form for the remainder of the flight scheduling process. Failure to electronically capture or use input that

was intermediately transformed on a PC is due primarily to the squadron's limited IT infrastructure.

a. Input

In a normal, peacetime environment, the flight scheduling process, in its current physical implementation, has up to nine inputs. Three flows of input are intermediately transformed and stored using PC-based application software. The resultant output, however, is hardcopy reports that are used in that form through the remainder of the flight scheduling process. The intermediate sub-processes' software applications are not integrated with each other, or, with the flight scheduling process.

(1) **Training Plans**. The training officer produces monthly and weekly training schedules. Weekly plans figure most prominently in daily flight scheduling. Training plans are print products.

(2) **"Ops Planner."** The Ops Planner is a rolling schedule of major events in the coming two to three months. The operations officer produces it using Softkey's Calendar Creator software. The format of the planner is a planning calendar. The blocks of days and weeks display important flight schedule-impacting squadron events on the dates on which they are to occur. Typically, events include major training exercises, operational commitments and scheduled maintenance of an aircraft that will last a day or more. The Ops Planner sets the framework within which to formulate future week's daily flight schedules.

(3) "**<u>Flight Hours Tracker</u>**." The Flight Hours Tracker is a spreadsheet that is produced using Microsoft's Excel software on a stand-alone PC in the operations department. The Flight Hours Tracker is used as a means by which to monitor funds authorized and spent for fuel, and the number of hours the squadron has flown. From that information, the Tracker computes total funding and spending for the current fiscal quarter and year, the squadron's cost per flight hour of operating its P-3s based on fiscal-year-to-date total funds spent and hours flown. The Tracker also computes the estimated flight hours that can be flown for the remainder of the quarter (based on remaining authorized funds for the quarter and the fiscal-year-to-date cost per flight hour). The projected flight hours that can be flown for the rest of the quarter is important input information for flight scheduling. Using this figure, the target average for daily flight hours that should be scheduled can be computed.

(4) "**<u>Pilot Proficiency Training Tracker</u>**." The Pilot Proficiency Training (PPT) Tracker is also a spreadsheet that is produced using Microsoft's Excel software on a stand-alone PC in the operations department. The PPT Tracker monitors pilots' progress toward completing required minimum training. Information from the PPT Tracker is used in daily flight scheduling as a guide for equitably allocating flight hours among pilots.

(5) **Flight Schedule Input**. Flight schedule input from aircrewmen comes in two forms: flight time summary sheets and flight schedule input forms.

(a) Flight Time Summary Sheet. This is the means by which a pilot records actual flight time at the end of a mission and communicates it to the operations officer.

(b) Flight Schedule Input Form. The flight schedule input form provides to aircrewmen a means by which to provide input to the operations officer for inclusion into the flight scheduling process. It may be used to request that an event be scheduled or that a scheduled event be changed. The form is simple, data is handwritten on it and the printed form is physically submitted to the operations department.

(6) **Aircraft Maintenance**. VP-40's aircraft maintenance department provides a daily forecast to the operations officer about aircraft availability and capability for the coming day. The forecast identifies which aircraft are anticipated to be flyable and which are not, as well as information about degraded aircraft sub-systems on all aircraft.

(7) **Personnel Administration**. VP-40's administration department provides input daily to the operations officer. Input concerns personnel who are not available for assignment to flight events due to their

absence from the squadron (e.g., temporary assignment to duties outside of the squadron, leave or liberty).

(8) **<u>Medical and Dental Readiness</u>**. Input from medical and dental is sporadic. Input may be in verbal or e-mail message form as well as written form. Usually, input is the result of an aircrewman reporting to the squadron flight surgeon or the supporting NAS's medical or dental department with an acute health problem. If the doctor, using standard Navy guidance, deems the condition sufficiently serious, he may temporarily remove the aircrewman from flight status; in that case, the medical or dental department immediately advises the squadron. Also, but less frequently, an aircrewman can be removed from flight status if certain periodic examinations are not completed on time.

(9) **<u>Input from CPW-10</u>**. Input from the staff of Commander, Patrol Wing 10 can come verbally in a meeting or conference or in the form of a telephone call, a memorandum or e-mail message.

b. Transformation

The operations officer is the focal point of eight streams of input, and ultimately must transform them into a flight schedule. However, the operations officer seldom acts unilaterally in that transformation.

Most often, the operations officer collaborates with those who have input into the flight scheduling process. But, the process is not truly collaborative; that is, it is rare that all parties simultaneously participate. Collaboration is usually

limited to a series of two-party communications between the operations officer and one of the other concerned parties at a time. (Flight scheduling is not normally done by conference as having five to seven daily flight schedule meetings plus an additional one every week to consider the upcoming weekly schedule is not practicable.)

Transforming input into a flight schedule is not a single linear process, but more akin to a parallel process that is iteratively performed. Competing requirements and the resources needed to satisfy them must compared on the bases of relative importance and timing.

c. *Flight Schedule*

The product of the flight scheduling process, of course, is a flight schedule. A flight schedule provides detail concerning flight missions or events to be flown for the day. It contains information such as the identity of the specific aircraft, the aircrew flying it, aircrewmen functional station assignments for the flight, purpose of the mission, locations (takeoff, intermediate stops, and final destination), and times (pre-flight briefing, pre-flight inspection and preparation of the aircraft, takeoff and landing). Currently, VP-40 publishes the flight schedule in hardcopy printed form.

D. SHORTCOMINGS OF VP-40'S FLIGHT SCHEDULING PROCESS

Logically, the process is sound. However, the process' information management is wholly inadequate in the context of today's commonly available

PC and LAN IT. What little IT that is now used in the flight scheduling process is rudimentary – word processing, spreadsheets and a calendar – limited in the degree to which it is applied, and not integrated.

Communicating, handling and manipulating information throughout the process is primarily via printed media. Input in such form, by nature of its physical properties, is inherently slow. Also, printed input is subject to physical barriers; that is, if the operations officer and the input sources are not in close proximity to one another, communicating input is very difficult.

Once in hand, input is difficult to use as it cannot be readily manipulated or melded with other input. Using information in hardcopy form is inefficient and requires too much of the operations officer's time and talents in the input phase. The time and effort the operations officer must spend on input is detrimental to optimizing the flight schedule, the process' most important aspect.

Finally, process output, a printed flight schedule, has the same negative qualities as input: inherently slow and difficult to disseminate.

E. CHAPTER SUMMARY

Flight scheduling is an essential function of a squadron. It is the process whereby resources and mission requirements are matched in order to produce maximum affect. In a normal peacetime environment, training requirements drive flight schedules. Training requirements are set forth by higher authority in syllabi for each type and model of aircraft.

The syllabi for the aircraft that a squadron flies forms the foundation upon which its training plans are built, and in turn its flight schedules. Flight scheduling is the responsibility of the squadron's operations officer.

Flight scheduling represents an optimization problem. Requirements must be maximally satisfied within certain constraints.

In VP-40, transformation of input into a proposed flight schedule is almost entirely a manual process.

IV. INFORMATION SPECIFICATIONS FOR FLIGHT SCHEDULING IN VP-40

A. INTRODUCTION

The process VP-40 uses to formulate flight schedules is sound. However, as the process is currently executed, its information quality – in terms of efficiency, timeliness, and accuracy (to the degree it is affected by timeliness) – could be significantly improved through the use of IT. Information formats (not to be confused with forms of media) and content are adequate. This chapter discusses why improving execution of flight scheduling is desirable, and describes the information requirement specifications for doing so.

B. NEED FOR IT IN FLIGHT SCHEDULING

Historically, abundant funding for flight hours and high rates of aircraft mission capability aircraft were a hedge against less than optimal flight schedules. Flight schedules not producing maximum utility per flight hour were of minor consequence. Whatever a particular schedule did not accomplish could be readily compensated for in later flight schedules. That is no longer the case. Reduced budgets for the Flying Hour Program (FHP), aircraft maintenance and spare components have increasingly limited flight hours available and degraded aircraft material readiness. Now, limited resources make it imperative that flight schedules be optimal. Furthermore, it is important that the process be efficient and agile. "Having the right information delivered to the right place at the right time

will reduce planning timelines, [and] improve course of action development." (NVI, 1997)

VP-40's flight scheduling process delivers the right kind of information, but is cumbersome and slow. When the quality of the information is assessed using the information quality criteria and measures that were discussed in Chapter II (i.e., including attributes in addition to content such as timeliness and accessibility), it is found to be lacking. The information quality of flight scheduling can be improved, however, by using IT to improve process execution. Using IT can increase the speed and efficiency of flight scheduling by eliminating manual procedures. This would enable the operations officer to focus more on the most important aspect of the process: optimization. Also, if the time required to produce a flight schedule is shortened, then flight scheduling becomes more responsive because it yields more time-relevant information.

1. Optimization

While optimization was always one of the goals in schedule writing, it was not the overriding goal. Whatever time and effort the operations officer could afford to apply to optimization was generally sufficient. That is no longer the case. Now, the operations officer's primary focus and effort as he formulates a weekly or daily flight schedule for the squadron must be on optimization.

Yet, the operations officer does not have additional time to spend on optimization. Spending more time on optimization means spending less time on

some other aspect of flight scheduling. In order to devote more time and effort to optimization, the operations officer must effectively buy time by gaining efficiency in other aspects of the process. An aspect of the process that is particularly inefficient and from which significant time and effort could be reclaimed by using IT is information handling. Currently, just gathering, formatting, validating, and organizing input information is tediously manual and requires significant time and effort by the operations officer. Such tasks are classic areas for IT application.

2. Responsiveness

Improving the agility of flight scheduling is important not only so the operations officer can focus on optimizing schedules, but also so the process can be more responsive. Limited resources make planning for maximal utility of flight hours, aircraft and aircrews all of the time – in stable, predictable times as well as in fast-paced, dynamic times – more important. Changes in requirements or resources must be readily accommodated by the flight scheduling process. Currency of input information should not impinge on process effectiveness and optimality of schedules, but rather enhance both.

C. SPECIFICATIONS

Improving the accuracy, agility and responsiveness of the flight scheduling process is possible through use of IT. But, IT must be applied with forethought of

purpose. Doing so means specifying what the desired salient characteristics of information quality in flight scheduling.

What are the specifications for information quality for VP-40's process of flight scheduling? Using the information quality attributes and descriptions provided in Joint Publication 6-0, Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations and in the Navy's ITSG (presented earlier in Tables 2.1 and 2.2 respectively), a set of attributes was formulated. Table 4.1 presents the specifications.

INFORMATION QUALITY ATTRIBUTES FOR FLIGHT SCHEDULING	
COMPLETENESS	All necessary elements required by the operations officer to make fully informed scheduling decisions about aircraft and aircrew employment.
PRECISION	The degree to which reality (i.e., resources available, constraints imposed, and conditions existing) is accurately conveyed; inherent characteristics are fidelity, granularity, brevity, and relevance.
USABILITY	The degree to which information is in a standardized, easily understood format.
ACCESSIBILITY	The degree to which needed information is readily available to the operations officer.
CURRENCY	The time delay between a fact of reality and its reflection as an element of information in the flight scheduling information system.
ECONOMY	The time, effort and expense of accessing, handling or producing information.
SECURITY	The degree of adequacy in which information is protected from compromise, corruption or improper devolution.

Table 4.1. Information Quality Attributes for Flight Scheduling

From this set of desired specifications two subsets were identified: those specifications now being adequately met, and those not being adequately met by the current flight scheduling process. Those not being met are where the

implementation of IT in flight scheduling must be focused first. Table 4.2 displays specifications for IT-21 implementation as it concerns flight scheduling and those that are now being satisfied (but could be considered for IT-based enhancement in the future).

TARGET SPECIFICATIONS FOR IT BASED ON FLIGHT SCHEDULING INFORMATION MANAGEMENT PERFORMANCE		
ATTRIBUTE	FOR IT-21TARGET	NOW MET/ POSSIBLE FUTURE TARGET
COMPLETENESS		X
PRECISION		X
USABILITY		X
ACCESSIBILITY	X	
CURRENCY	X	
ECONOMY	X	
SECURITY	X	

Table 4.2. Information Quality Attributes to be Targeted for Improvement Via IT

In summary, VP-40's flight scheduling process lacks quality in how it moves and manipulates information, not in its information content. Consequently, IT-based improvement must focus on improving the process' handling of information, especially input (i.e., consolidating and validating input, and fusing input from multiple sources).

The following describes the performance that is expected of the IT that is intended to improve the flight scheduling process. Categorizing performance in distinct attribute categories is somewhat artificial, however. There are inter-dependencies among attributes, and therefore performance.

1. Accessibility

Generally, accessibility to information flowing into and out of the flight scheduling process must be ubiquitous via the squadron's LAN. Time, day or geographic location should not limit access. Access should be available locally by hard-wire connection to the LAN, or remotely by Internet or modem.

a. Input

Accessibility to input information with respect to content should be limited via a permission mechanism controlled by the operations officer using a "need-to-know" basis. Individuals and activities routinely having input into the flight scheduling process must be able to offer new input or review input already made without restriction. The operations officer must have on-demand access to input information for flight scheduling. The repository from which the information is drawn is immaterial. Access could be via a central repository in which input for any given future flight schedule is accumulated until requested by the operations officer, or via access to distributed repositories of such information (e.g., one for every squadron department having input). In any event, there should be no latency in input once the operations officer requests it. Also implied, is no human intervention be required between the operations officer indicating he is ready for input information and receiving it (i.e., no translation from one form of media to another). Ideally, input the operations officer could readily assimilate information, however, intermediate reformatting would be acceptable as long as it

requires no additional effort (i.e., an automatic reformatting mechanism via software).

b. Output: The Flight Schedule

Once the operations officer has formulated and published a flights schedule, squadron members and authorized individuals and activities outside of VP-40 (e.g., CPW-10, the NAS Whidbey Island Operations Department) must have access to flight schedules. Level of detail would be controlled in a fashion to how input accessibility is controlled, that is, using permissions governed by the operations officer.

2. Currency

a. Input

Input latency compromises the relevance of flight schedules. As the amount of time required for incorporating input into the process increases, the probability that the input is no longer accurate increases. Therefore, a flight schedule based on aged input may not be relevant to the reality of the flight schedule time period (i.e., day or week).

Input should not be a discrete event, but rather a continuous one. There is no need for an explicit or implicit request for input. The data required, and its formats and forms are known and constant. Only the data elements' values change. Periodicity of input incorporation is also known (i.e., flight schedules are written weekly and daily). In short, the input requirement is a standing,

continuous one. The operations officer's consideration of the input in his decision making is a discrete event. Input should constantly flow from its sources so that at any given time the operations officer can produce a flight schedule for a future day or week based on what is known at that time. Any input made, but not entering the process before it begins, could simply be queued for the next flight scheduling evolution. Input should flow without human intervention or assistance, or regard to its time or place of origination.

b. Flight Schedule Output

Flight schedules should be produced and incorporate the latest input up until the time execution begins or has progressed to a point where changing the flight schedule is moot. Once a flight schedule has been produced, validated and approved for publication by the operations officer, it should be immediately available to all concerned. Published schedules should reflect reality as accurately as possible and be updated as changes in input factors dictate.

3. Economy

Information's format and form largely drive the effort and expense of accessing, handling or transforming it. The most economical formats are those that are standard so as to preclude reformatting. The most economical form or medium is electronic data because of its wide coverage, timely and inexpensive transmission. VP-40's flight scheduling information should be in standard formats

exchanged and manipulated using PC-based means (e.g., the squadron LAN, software).

a. Input

The format and form of input must be usable upon receipt in the Operations Department. Input should be entered only once, at the source, and be usable in flight scheduling from that point onward. Readily usable input form fosters speed. Speed reduces required lead-time for the process to produce a flight schedule. Reduced lead-time means that flight schedules can incorporate more up-to-date information. Flight schedules based on more recent information are more relevant and require fewer changes. In the end, all-electronic form can add value to flight schedules.

b. Transformation

This is the process of melding input together (accumulating, sorting, and weighting) to distill a preliminary flight schedule serving as the framework within which the operations officer performs sensitivity analysis and optimization. Synthesizing a flight schedule is often a collaborative process. While collaboration is not always necessary or desired, it must be an option. Deployed squadron detachments at remote sites, or key personnel such as department heads, the executive officer or the commanding officer should be easily included in the flight schedule decision making process despite their geographic location. Collaboration helps stabilize quality and improve timeliness of flight schedules.

c. Flight schedule output

The format and form of published flight schedules should facilitate display on PC monitors of various sizes as a Web page, and should be easily printed. Also, the format must be readily alterable to facilitate any long-term changes in flight schedule information content.

4. Security

Within the scope of this thesis, security concerns the integrity of flight schedule information during routine, peacetime operations, and it does not concern the protection of classified information. Security of flight schedule information must be provided (e.g., via permissions for accessibility and alteration of information) and it must be controllable by the operations officer.

D. CHAPTER SUMMARY

Increasingly scarce flight hours and mission-capable aircraft compel VP-40 to seek maximum utility of those resources. Optimal flight schedules have never been more important. Yet, the operations officer cannot afford to devote more of his time or effort to optimization. To do so, the inefficient, time-consuming techniques for handling information in the process must be replaced. The process must be executed more quickly and economically. Such needs lend themselves to common PC-based IT solutions.

Successful introduction of IT into any process is based upon information management requirements. In the case of VP-40's flight scheduling process, the

basic requirement is assuring information quality. Information quality is a function of information content and of how information is handled as it traverses a process. VP-40's scheduling process has adequate information content. However, information manipulation relative to the attributes defined in Table 4.1 is inadequate. The introduction of IT must target information accessibility, currency, economy and security.

Establishing a good IT infrastructure for handling information can also serve as the basis for introducing more sophisticated applications of IT in the flight scheduling process later (e.g., a decision support system).

V. IT- 21 MAPPED TO THE INFORMATION REQUIREMENTS SPECIFICATIONS FOR VP-40'S FLIGHT SCHEDULING PROCESS

A. INTRODUCTION

The information requirements for VP-40's flight scheduling process, as presented in Chapter IV, can be met using components of IT-21. Using IT-21's LAN architecture and some of its application software, the quality of information in the flight scheduling process can be improved in terms of accessibility, currency, economy and security. Such improvements would enable collaborative work capability that could increase process speed and the optimality of flight schedules. Speed would accrue simply from physical information flows being replaced with electronic information flows. Better flight schedules would be possible through the collaborative work capability.

B. MAPPING IT-21 COMPONENTS TO INFORMATION REQUIREMENTS

The flight scheduling process of VP-40 can be improved with IT. Merely implementing the IT presented in IT-21 will not improve flight scheduling. However, specific IT components of IT-21 implemented based on the specified information management requirements of flight scheduling can improve the overall process.

1. Hardware

The specifications for hardware components under IT-21 are straightforward as set forth in the joint CINCLANTFLT-CINCPACFLT message

that formally announced IT-21 (see Appendix). By procuring and installing a set of hardware components based upon the information requirements, VP-40 can produce flight scheduling process improvements.

a. Home Base

Using IT-21-specified hardware, the minimum architecture that is required for improving the process of flight scheduling would be a LAN that links at least all of the primary participants involved in the process. Necessary hardware would include a Fast Ethernet LAN that would link a server and the PCs of each of the key figures in the flight scheduling process (i.e., the CO, XO, operations officer, training officer, NATOPS officer, aircraft maintenance officer, personnel officer and medical officer). Such a LAN would enable those individuals in VP-40 who are integral in the flight scheduling process to readily access information essential to the process. Information currency would increase because facts could be shared over the LAN with virtually no delay. Economy would increase because sharing information electronically requires very little effort or time. Security of flight scheduling information would increase because the LAN, when coupled with the NOS (discussed later), would allow the operations officer to dictate access rights.

b. Squadron Detachments and Individual Personnel On Travel

VP-40 often deploys detachments of one or more aircraft to other sites, or sends individuals on travel who are key in the flight scheduling process.

In either case the geographic separations, sometimes spanning multiple time zones, reduce the efficacy of flight scheduling for the squadron overall. The deleterious affect of time and distance on the information flows and collaborative work of the flight scheduling process could be ameliorated by remote access capability to the VP-40 LAN. For this purpose, the LAN should have remote access capability, and a small pool of notebook PCs should be available for detachment officers-in-charge and other essential personnel to use via telephonic dial-in.

2. Software

Of the software product set specified by IT-21, use of Microsoft's Windows NT and Office 97 can improve the quality of information in VP-40's flight scheduling process relative to the information requirements that were identified in chapter IV. Accessibility, currency and economy can improve through use of Office and Exchange. Security – not in terms of protecting classified information, but rather integrity of unclassified information commonly used in flight scheduling – can be enhanced through the use of the Windows NT NOS.

a. Windows NT

Windows NT is required because it is the NOS on which the LAN would run. Windows NT provides the common environment from which the applications of the Microsoft product set would run and be shared among users.

Beyond that, Windows NT can enable the operations officer to better control the integrity of flight schedule information.

(1) **Domain Security Model.** The Windows NT domain security model provides a number of security features. A domain is "an arrangement of client server computers referenced by specific name that share a single security permission database." (Strebe, Perkins and Chellis, 1997) The domain security model "governs the interactions of clients and Windows NT servers in a server-based network with a Windows NT server coordinating the security of the network." (Strebe, Perkins and Chellis, 1997) In domains, network user accounts are centrally managed.

(2) **Security Features.** Each user has prescribed privileges by virtue of the user's individual privileges and those accorded through the user's membership in domain groups. Each object (e.g., files and directories) within Windows NT has an access control list (ACL). An ACL contains information that identifies users and groups who are authorized access to the object and the type of access that they have. In Windows NT, resources can be designated as shared network resources available to all users. Those resources that are shared have permissions that control the type of access that is permitted via the network (but not locally). Finally, the Windows NT file system (NTFS) has a set of permissions that can be used to further fine-tune security at the file level. The

security features of Windows NT can enable VP-40's operations officer the means by which to ensure a higher degree of integrity of flight scheduling information.

b. Office 97

The Office 97 group of software applications, when used in a LAN environment can enable communication and collaboration in an information process. Those capabilities influence the management of information in terms of accessibility, currency and economy. These three characteristics, as defined in Chapter IV, are targets for improvement in VP-40's flight scheduling process. Office 97 can facilitate their improvement.

(1) **<u>Results in a Corporate Setting</u>.** Office 97 has been used extensively in corporate settings that have characteristics that are similar to those of flight scheduling in VP-40; that is, processes which are complex, mission-critical and time-sensitive that are executed in environments in which conditions constantly and often rapidly change. Office 97's performance as a communication and collaboration vehicle was independently studied by International Data Corporation (IDC) in 1997. IDC surveyed six corporations, from a variety of industries, having national or global interests. All were early adopters of Office 97. The purpose of the survey was to determine the degree to which Office 97's communication and collaboration tools enabled the organizations to achieve their goals in less time, with greater value, and at lower cost. IDC examined how well Office 97 enabled the corporations to: capture and use information in spite of time

and distance, manage information, leverage knowledge, reduce duplicate efforts by sharing information, and make better-informed and faster decisions. Office 97 was found to have significantly helped all six organizations enhance their knowledge by enabling better sharing and managing of information. In addition, Office 97 was found to have helped the organizations streamline their processes, become more competitive and more responsive. (Christianson, 1997) These results are encouraging. However, because of the small sample size that was used, it should not be inferred that the Navy, under IT-21, would necessarily benefit to the same degree.

(2) **Using Office 97 to Improve VP-40's Flight Scheduling *P*rocess.** The e-mail capability of Office 97 can enable VP-40's operations officer to communicate and collaborate with other parties in the flight scheduling process. Collaboration could expand to include those who are not physically nearby (provided that the remotely located party has dial-in capability). Locally, it no longer would require many time-consuming, one-on-one communications (in person or telephonically) between the operations officer and others. Information would be communicated and collaboration performed via e-mail messages. Messages could be one-to-one or one-to-many. The time that could be saved by doing this alone would be valuable. However, the fact that collaboration could be performed in much less time could also spur more frequent and rigorous collaboration. Thus, the flight schedule optimization could be further enhanced.

Overall, Office 97 would assist the operations officer in harnessing flight scheduling information and streamlining the process. (Christianson, 1997)

(3) **Drawbacks of Using Office 97 for VP-40's Flight Scheduling Process**. Office 97 does not include features that enable one to control or monitor the progressive flow of collaborative work on documents, spreadsheets or databases. Office 97 focuses on information creation and retrieval, but not on the process of information movement. (Christianson, 1997)

C. ORGANIZATIONAL AND PERSONNEL CONSIDERATIONS

While IT-21 offers some potentially promising means by which VP-40 could improve its flight scheduling process, there are also potential pitfalls associated with IT-21. Training will be required for users to become proficient in the use of IT-21's applications software to be able to fully exploit it. For example, someone must know the various application software systems to be able to create a LAN based flight scheduling system that is more than an electronic version of today's paper-based system (e.g., input validation through software is needed). More crucial, is that at least one person must be trained to configure and maintain the Windows NT NOS and function as system administrator. Mastering the Windows NT NOS software, which is essential to operation of the LAN, is not trivial. It can require hundreds of hours and cost thousands of dollars.

This leads to a second point of concern. The organizational structure of VP-40 would be affected at a minimum by the need for at least one dedicated

system administrator. In VP-40 today, there is no billet for such an individual. However, with other functions taking advantage of the LAN and IT-21 the efficiencies realized might outweigh the cost in personnel.

D. CONCLUSIONS

IT-21 can improve information quality in VP-40's flight scheduling process. Information quality relative to an organizational process has two major components: (1) content and (2) the efficacy with which information is handled. VP-40's flight scheduling process is adequate in its information content, but is lacking in how it handles information.

This thesis describes a systematic approach for shaping IT-21 to the flight scheduling function of VP-40 – that is, "operationalizing" IT-21 in flight scheduling. This approach could be applied to other functions in the squadron. By methodically applying the approach in each of the squadron's functions, a mosaic of information management requirements for IT-21 could be formed. That mosaic would paint an overall picture of squadron information requirements to shape the implementation of IT-21 to VP-40's needs. This is important, because while IT-21 provides guidance on the use of hardware and software resources, the precise information requirements for individual ships and squadrons are not prescribed.

APPENDIX. INFORMATION TECHNOLOGY FOR THE 21ST CENTURY

ADMINISTRATIVE MESSAGE

ROUTINE

R 300944Z MAR 97 ZYB PSN 307047I21

FM CINCPACFLT PEARL HARBOR HI//N00//

TO ALPACFLT
ALLANTFLT

INFO ASSTSECNAV RDA WASHINGTON DC//C4I//
CNO WASHINGTON DC//N00/N09/N095/N2/N4/N41/N43/N46/N6/N6B/
N8/N80/N85/N86/N87/N88//
CINCLANTFLT NORFOLK VA//N00/N6//
CINCUSACOM NORFOLK VA//J00/J6//
USCINCPAC HONOLULU HI//J00/J6//
CINCUSNAVEUR LONDON UK//00/N6//
COMNAVSEASYSCOM WASHINGTON DC//N00/N08/PMS335/PMS3//
BUMED WASHINGTON DC//N00//
RUCJNAV/COMUSNAVCENT//N00/N6//
CNET PENSACOLA FL//N00//
BUPERS WASHINGTON DC//N00//
COMMARFORPAC//CG/G6//
COMMARFORLANT//CG/G6//
COMSPAWARSYSCOM WASHINGTON DC//N00/N05/PMW171/PMW176//
NAVSTKAIRWARCEN FALLON NV//N00//
COMNAVSECGRU FT GEORGE G MEADE MD//N00//
COMNAVSUPSYSCOM MECHANICSBURG PA//N00//
COMNAVSPECWARCOM CORONADO CA//N00//
NRL WASHINGTON DC//N00//
COMNAVCOMTELCOM WASHINGTON DC//N00/N3//
NAVMASSO CHESAPEAKE VA//N00/N6//
NCCOSC RDTE DIV SAN DIEGO CA//N433//
CINCPACFLT PEARL HARBOR HI//N00//

THIS IS A 2 PART MSG COLLATED BY MDS

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ALPACFLT 008/97

MSGID/GENADMIN/CINCPACFLT/008//

SUBJ/INFORMATION TECHNOLOGY FOR THE 21ST CENTURY// POC/M.R.
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RMKS/1. THIS IS THE FIRST IN A SERIES OF JOINT CINCPACFLT AND
CINCLANTFLT MESSAGES CONCERNING THE DEVELOPMENT AND
IMPLEMENTATION OFIT-21. THIS MESSAGE PROVIDES IT-21

HARDWARE/SOFTWARE IMPLEMENTATION STANDARDS FOR PROGRAMS INSTALLING INFORMATION SYSTEMS ON FLEET UNITS/BASES AND PROVIDES THE FLEET WITH GUIDANCE ON MAINTAINING EXISTING INFORMATION SYSTEMS UNTIL INSTALLATION OF IT-21 PRODUCTS. THE IT-21 IMPLEMENTATION STANDARDS OUTLINED BELOW ARE PROMULGATED IN ADVANCE OF DON-WIDE GUIDANCE FROM THE DON CHIEF INFORMATION OFFICER (CIO). THE DON CIO WILL PROMULGATE DON-WIDE STANDARDS FOLLOWING NEGOTIATION OF ENTERPRISE-WIDE NETWORK OPERATING SYSTEMS AND APPLICATIONS.

2. BACKGROUND: INFORMATION SUPERIORITY IS THE FOUNDATION OF JOINT VISION 2010 BATTLEFIELD DOMINANCE, AS WELL AS THE WARFIGHTING VISION FOR EACH SERVICE. NETWORK WARFARE, ROBUST INFRASTRUCTURE AND INFORMATION DISSEMINATION TO DISPERSED FORCES ARE KEY ELEMENTS IN ACHIEVING INFORMATION SUPERIORITY. IT-21 IS A FLEET DRIVEN REPRIORITIZATION OF C4I PROGRAMS OF RECORD TO ACCELERATE THE TRANSITION TO A PC BASED TACTICAL/TACTICAL SUPPORT
WARFIGHTING NETWORK. THE INACTIVATION OF THE CURRENT DOD MESSAGING SYSTEM (AUTODIN) BY DEC 99, WITH NO PLANNED NAVY INFRASTRUCTURE REPLACEMENT, MANDATES THE RAPID IMPLEMENTATION OF THIS WARFIGHTING NETWORK.

3. COMMERCIAL NETWORK OPERATING SYSTEMS (NOS) AND E-MAIL PRODUCTS HAVE ACHIEVED FUNCTIONAL PARITY. THE FLEETS CANNOT CONTINUE TO SUPPORT A MULTITUDE OF DIVERSE OPERATING SYSTEMS AND E-MAIL PRODUCTS WITH THEIR OWN TRAINING, OPERATIONAL PROCEDURES AND TROUBLESHOOTING REQUIREMENTS. THE DOD JOINT TECHNICAL ARCHITECTURE (JTA) AND DEFENSE INFORMATION INFRASTRUCTURE COMMON OPERATING ENVIRONMENT
(DII COE) PROVIDE DOD WITH THE AIS SYSTEM GUIDANCE REQUIRED TO TAKE THE NAVY INTO THE 21ST CENTURY. THIS CONVERGENCE OF SOLUTIONS, PROBLEMS AND GUIDANCE PROVIDES THE IMPETUS TO ESTABLISH MINIMUM
NAVY AIS STANDARDS AT THIS TIME. IMPLEMENTATION OF THIS POLICY REQUIRES ALL NON-STANDARD NOS AND E-MAIL PRODUCTS BE REPLACED NLT DEC 99.
A. WINDOWS NT SERVER 4.0 IS THE STANDARD FLEET NOS. IT WILL SOON BE FOLLOWED BY WINDOWS NT 5.0. WINDOWS NT SERVER 4.0 IS DII COE COMPLIANT.
B. MS EXCHANGE IS DESIGNATED AS THE STANDARD E-MAIL SOLUTION FOR BOTH FLEETS TO ENSURE AN INTEROPERABLE SECURE MESSAGING SYSTEM IS OPERATIONAL PRIOR TO AUTODIN INACTIVATION NLT DEC 99.
C. MS OFFICE 97 IS DESIGNATED AS THE STANDARD FLEET OFFICE SOFTWARE.
D. EXPENDITURE OF OPERATING FUNDS TO MAINTAIN EXISTING IT-21 NONCOMPLIANT NOS AND APPLICATIONS SHALL BE THE ABSOLUTE MINIMUM NECESSARY TO MEET OPERATING REQUIREMENTS UNTIL IT-21 NOS/SOFTWARE IS INSTALLED EVEN IF TEMPORARY LAN DEGRADATION OCCURS. SOFTWARE REQUIREMENTS DRIVE HARDWARE STANDARDS. HARDWARE AND SOFTWARE PURCHASED TODAY MUST BE CAPABLE OF MEETING MISSION REQUIREMENTS THROUGH THE YEAR 2000.

4. CINCPACFLT AND CINCLANTFLT ARE ACTIVELY WORKING WITH OPNAV ON IT-21 FUNDING AND IMPLEMENTATION PLANS. IN GENERAL, AFLOAT

IT-21 IMPLEMENTATION WILL BE LINKED TO DEPLOYING BATTLEGROUPS AND ASHORE IT-21 WILL BE IMPLEMENTED IN A PHASED APPROACH. SPECIFIC IMPLEMENTATION SCHEDULES WILL BE PROMULGATED AT A LATER DATE. CINCPACFLT AND CINCLANTFLT ARE TRANSITIONING TO WINDOWS NT 4.0, MS EXCHANGE AND MICROSOFT OFFICE 97. THIS ENVIRONMENT CANNOT BE OPTIMIZED WITHOUT 32 BIT OPERATING SYSTEMS, HIGH RESOLUTION
DISPLAYS AND MASS STORAGE. ATM BACKBONE LANS WITH AT LEAST 100 MBS (TCP/IP)TO THE DESKTOP PC WILL BE INSTALLED ON ALL SHIPBOARD LANS, FLEET HEADQUARTERS (CPF, CLF, TYCOMS, GROUP AND SQUADRON COMMANDS) AND SHOULD BE INSTALLED IN THOSE SHORE ACTIVITIES THAT SUPPORT TACTICAL OPERATIONS. THIS WILL THEN ALLOW TRANSITION TO ATM-TO- THE-DESKTOP PC WHEN THE ATM TECHNOLOGY MATURES.

5. SYSTEM COMMANDS AND PROGRAM MANAGERS:
A. NTCSS WILL BECOME THE IT-21 PROGRAM OF RECORD FOR INSTALLATION OF BOTH SECRET AND UNCLASSIFIED LANS ONBOARD COMMISSIONED SHIPS. NTCSS (ATIS/SNAP III) LANS INSTALLED FROM THIS POINT ON WILL HAVE AN ATM BACKBONE, 100 MBS (FAST ETHERNET) TO THE DESKTOP PC AND THE HARDWARE/SOFTWARE OUTLINED AT THE END OF THIS.MESSAGE. THE MIGRATION OF NTCSS LANS TO HIGHER CAPACITY LANS WILL REDUCE THE NUMBER OF PC'S DELIVERED DURING INITIAL INSTALLATION. THE TRADE-OFF OF QUANTITY FOR FRONT END PC'S IS REQUIRED TO SUPPORT JV-2010 AND AUTODIN INACTIVATION.
B. SPAWAR IS WORKING WITH NAVSEA TO ENSURE THAT LANS INSTALLED DURING NEW CONSTRUCTION MEET THE IT-21 REQUIREMENTS.
C. APPLICATION PROGRAM MANAGERS SUCH AS JMCIS, NSIPS, TAMPS, AND GCSS SHOULD MIGRATE CURRENT APPLICATIONS TO THE DII COE WITH AN IMMEDIATE OBJECTIVE OF OBTAINING PC WORKSTATION ACCESS TO ALL APPLICATION DATA ON AN ENTERPRISE LAN.
D. PROGRAMS INSTALLING INFORMATION SYSTEMS (NEWNET, SMARTLINK, SMARTBASE, TELEMEDICINE, ETC.) MUST INSTALL COMPONENTS IN FLEET ACTIVITIES THAT MEET IT-21 STANDARDS AND PROVIDE INTEROPERABILITY THROUGHOUT THE WARFIGHTING NETWORK.

6. TYCOMS AND THIRD ECHELON COMMANDS SHALL ENSURE THAT:
A. SHIPS AND ACTIVITIES INSTALLING NEW LANS, UNDERGOING SIGNIFICANT LAN UPGRADES OR THOSE ACTIVITIES WITH STAND ALONE PC'S SHALL INSTALL IT-21 HARDWARE AND SOFTWARE. NEW OR REPLACEMENT SHIPBOARD AND SHORE BASED TACTICAL LANS SHOULD HAVE AN ATM BACKBONE WITH AT LEAST 100 MBS (FAST ETHERNET) TO THE PC.
B. SHIPS AND ACTIVITIES WITH EXISTING LANS, WHICH REQUIRE REPLACEMENT OF UNSERVICEABLE HARDWARE, SHORT OF A FULL NETWORK UPGRADE, SHALL INSTALL HARDWARE WHICH MEETS IT-21 STANDARDS. THE NEW EQUIPMENT MAY NOT BE COMPATIBLE WITH THE EXISTING LAN HARDWARE. CINCPACFLT AND CINCLANTFLT BELIEVE THAT ALL AUTOMATED INFORMATION SYSTEMS (AIS) PROCURED MUST BE COMPATIBLE WITH THE IT-21 LAN STANDARDS EVEN IF TEMPORARY LAN DEGRADATION OCCURS. THERE IS ONLY SUFFICIENT FUNDING TO DO IT RIGHT THE FIRST TIME.

7. THE IT-21 STANDARDS BELOW REPRESENT FRONT END MARKET TECHNOLOGY, ARE DYNAMIC IN NATURE, AND WILL CONTINUE TO BE CLOSELY LINKED TO COMMERCIAL TRENDS. THE STANDARDS LISTED BELOW ARE INTENDED TO BE MINIMUM STANDARDS AND WILL BE UPDATED PERIODICALLY.

A. IT-21 LAN:
(1) AFLOAT LAN STANDARDS - ATM FIBER BACKBONE, 100 MBPS
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(FAST ETHERNET) TO THE PC.
(2) ASHORE TACTICAL AND HEADQUARTERS COMMAND CENTER STANDARD (CPF, CLF, TYCOMS, GROUP AND SQUADRON COMMANDS) - ATM BACKBONE, 100 MBPS (FAST ETHERNET) TO THE PC.
(3) ASHORE TACTICAL SUPPORT COMMAND STANDARDS (BASES) - ATM BACKBONE, 100 MBPS (FAST ETHERNET) TO THE PC.
(4) METROPOLITAN AREA NETWORKS (MAN) SHOULD BE CAPABLE OF SUPPORTING AT LEAST OC-3 (155MBS).
B. IT-21 SOFTWARE:
- WINDOWS NT 4.0/5.0 WORKSTATION
- MS OFFICE 97 PROFESSIONAL (WORD 97, POWERPOINT 97, EXCEL 97, S ACCESS 97)
- IBM ANTI VIRUS (NAVY LICENSE, AVAIL FROM NAVCIRT) - MS BACK OFFICE CLIENT
- MS OUTLOOK 97
- MS EXCHANGE 5.0
- MS IMAGE COMPOSER
C. IT-21 DATABASES. RELATIONAL DATABASES THAT CAN SUPPORT WEB TECHNOLOGY IAW THE COE (ORACLE, SYBASE, SQL SERVER, ACCESS, ETC.) WILL BE USED TO SUPPORT DATA REQUIREMENTS AND APPLICATION DEVELOPMENT. ALL PROCESS ENGINEERING INITIATIVES THAT RESULT IN DESIGN/REDESIGN OF A DATA COLLECTION/CAPTURE SYSTEM MUST USE COE COMPLIANT RELATIONAL DATABASE MANAGEMENT SYSTEMS (RDBMS) SOFTWARE. THIS REQUIREMENT IS PROVIDED TO ENSURE RDBMS INITIATIVES USE COTS APPLICATION SOFTWARE. FOR ADDITIONAL INFORMATION ON RELATIONAL DATABASES CONTACT CDR SANDY BUCKLES, CPF N67, COMM/DSN (808) 474-6384, NIPRNET U67@CPF-EMH.CPF.NAVY.MIL.
D. MINIMUM IT-21 PC CAPABILITIES: CPF CAN CURRENTLY PURCHASE THE IT-21 STANDARD PC WITH SOFTWARE FOR $3250.00 - $3579.00 - SEE PARA 7(H) AND 7(I).
- 200 MHZ PENTIUM PRO CPU
- 64 MB EDO RAM
- 3.0 GB HARD DRIVE
- 3.5 INCH FLOPPY DISK DRIVE
- 8X IDE CD-ROM
- DUAL PCMCIA/PC CARD READER
- PCI VIDEO W/2MB RAM
- 17 INCH MONITOR (1280 X 1024)
- POINTING DEVICE (TRACKBALL OR MOUSE)
- SOUNDBLASTER (COMPATIBLE) AUDIO CARD WITH SPEAKERS KEYBOARD - CPU COMPATIBLE 100 MBPS FAST ETHERNET NIC
E. STANDARD IT-21 LAPTOP WORKSTATION: APPROXIMATELY $5300 - SEE PARA 7(H).
- 150 MHZ PENTIUM
- 32 MB EDO RAM
- 12.1 IN SVGA ACTIVE MATRIX COLOR DISPLAY - 2.1 GB EIDE HDD
- 6X INTERNAL CD-ROM
- MODEM, PCMCIA SLOTS, NIC CARD
- SMART LITHIUM BATTERY

F. IT-21 NT FILE SERVER FOR DIRECTORY NETWORK SERVICE: APPROXIMATELY $26K - SEE PARA 7(H). THESE ARE MINIMUM SPECIFICATIONS. NEEDS OF THE SPECIFIC NETWORK WILL DICTATE REQUIREMENTS.
- DUAL 166 MHZ PENTIUM CPU
- 512K SECONDARY CACHE MEMORY- 256 MB RAM - TWO 4 GB SCSI HDD
- ONE 6 GB DAT DRIVE
- ONE 3.5 INCH FLOPPY DISK DRIVE
- 6X SCSI CD-ROM
- DUAL PCMCIA/PC CARD READER
- 2 DPT SCSI III CACHING CONTROLLERS (SMARTCACHE 4) - PCI VIDEO W/2MB RAM
- 17 INCH MONITOR (1280 X 1024)
- POINTING DEVICE (TRACKBALL OR MOUSE) - KEYBOARD
- TWO CABLETRON CPU COMPATIBLE ATM NIC CARDS
- ANTEC DUAL POWER SUPPLY CASE (HOT SWAPPABLE)

G. IT-21 FILE SERVER/APPLICATION SERVER: APPROXIMATELY $26K - SEE PARA 7(H). SAME AS IT-21 NT FILE SERVER FOR DIRECTORY NETWORK SERVICE WITH THE FOLLOWING CHANGES:
- CHANGE HDD RQRMT TO FIVE 4 GB DRIVES - CHANGE DAT TO 18 GB.

H. PRICES FOR PC TECHNOLOGY ARE CONSTANTLY CHANGING AND CAN VARY GREATLY DEPENDING ON METHOD OF PROCUREMENT. FOR EXAMPLE, ON 28 MAR 97 AN IT-21 PC PURCHASED DIRECTLY FROM A VENDOR COSTS $3643. GOVERNMENT RATE FOR SMALL PURCHASES (LESS THAN TEN) IS $3579.
A BULK PROCUREMENT (MORE THAN SEVENTY-FIVE) COSTS $3250. THE ABOVE PRICES INCLUDE SHIPPING. BULK PROCUREMENTS SHOULD BE MADE THROUGH THE TYPE COMMANDERS WHEN APPROPRIATE. MR. RICK KOOKER, CPF N65, COMM/DSN:(808) 474-5882, NIPRNET: U65@CPF-EMH.CPF.NAVY.MIL IS AVAILABLE TO ASSIST TYCOMS WITH AIS PROCUREMENT ISSUES.

I. AS NETWORK COMPUTER TECHNOLOGY EVOLVES SOME COMMANDS MAY BE ABLE TO TRANSITION TO NETWORK COMPUTERS. WHEN CONSIDERING INSTALLATION OF NETWORK COMPUTERS, TOTAL NETWORK COST MUST BE EVALUATED. NETWORK COMPUTERS HAVE NOT MATURED SUFFICIENTLY TO IMPLEMENT THEM IN FLEET PLATFORMS AT THIS TIME.

8. WAIVER REQUESTS FROM THE ABOVE STANDARDS SHOULD BE SUBMITTED DIRECTLY TO THE RESPECTIVE CPF/CLF N6. POINTS OF CONTACT ARE AS FOLLOWS:

A. CINCLANTFLT: CDR DEBRA STRAUB AT COMM (757) 322-5863, NIPRNET: U6@CLF.NAVY.MIL

B. CINCPACFLT: CDR MIKE SCOTT AT COMM (808) 474-7860, NIPRNET:U6@CPF-EMH.CPF.NAVY.MIL.//

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